PCAS 220 (2017/2018)

Supervised Project Report
(ANTA604)

Webtoons,
a tool for communicating Science in Antarctica

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Word count: 6451 (excluding abstract and references)

Abstract:

The use of comics in education is well researched and is acknowledged as a successful instructional tool and learning strategy in reading comprehension through to scientific content knowledge, especially where Generation N (people who grew up after 1980 and who are familiar with the internet) is concerned. The comic format has continued to evolve as a visual narrative and is currently in use as an online mass media communication tool more popularly known as a 'webtoon'.

In acknowledgement of the fourth International Polar Year (IPY) where the importance of polar science education, outreach and communication with the public was highlighted, the following project researches the success of comics in education and as a science communication tool. The research of comics is carried out with a view to applying the same knowledge and understanding into developing and producing a webtoon intended for outreach and communicating science in Antarctica to the general public globally.

Acknowledgments

I would like to thank and acknowledge the efforts of my lecturers during the PCAS 2017-18 programme, especially the leadership demonstrated by my project supervisor Dr. Elizabeth Leane and our course co-ordinator Daniel Ligget. I would also like to acknowledge Gateway Antarctica, the University of Canterbury and AntarcticaNZ for supporting the PCAS programme and ultimately giving people like myself, coming from a diverse background, the opportunity to get involved in Antarctic science. I aim to share the knowledge and understanding that I have gained with my own students and network of professionals in the engineering industry. I extend my thanks to the many speakers who came to visit us and who we had the privilege to listen to during the programme, I was in awe of their passion, dedication and enthusiasm shown towards Antarctic research. Finally, many thanks to the staff and field guides at Scott Base, you made room for our large group and we felt welcome in your company.

My time spent learning about science in Antarctica and spending time in Antarctica itself, is an experience that I will appreciate and treasure for years to come.

Go raibh míle maith agaibh go léir, Ríonach Ní Chléirigh
Thanks a million everyone, Regina Clery

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1 Introduction

The use of comics in education is not new, but how popular and successful are comics as an instructional tool? What is the potential for using an online adaptation of the same tool - a 'Webtoon' as a form of mass media to communicate with the public about science, and specifically science in Antarctica?

Section one of this project sets out the reasoning behind developing an online comic or 'Webtoon' for communicating science in Antarctica by outlining the importance that underlined polar research education, outreach and communication, as highlighted by the fourth International Polar Year (IPY). To help focus the target audience of the 'Webtoon', the educational preferences and communication needs of 'Generation N', people born after 1980 in the age of the internet, is also addressed. Section one also includes a classification and description of the most basic graphic narratives to clarify the terminology used throughout the project.

Section two of the project introduces the use of comic narratives in education, focusing on the pedagogy and andragogy associated with the education of adolescents and the preferences of Generation N. Section two then moves on to discuss comic narratives in sciences education specifically and the interpretation of different types of educational science comics. This section concludes by assessing how transferrable the application of comic narratives in education is to a science communication context.

Section three moves on from comics generally to webtoons particularly, associating the success that webtoons have in mass media communication with the success that comics have in education. Science communication using Webtoons as a medium is addressed specifically in section three with a reference to current webtoons sourced to demonstrate how flexible the medium is as an educational communication tool. A brief description of how to interpret webtoons is also discussed in section three.

It was intended that section four would analyse the knowledge, skills and processes required to develop an actual useful webtoon to communicate science in Antarctica. The content of section four would address storyline, target audience, character development, webtoon interpretation and format, software use and online formatting. However due to time constraints, following the return of PCAS students from Antarctica in February 2018, section four is now put on hold with the intention

to revisit and develop an actual Webtoon to communicate science in Antarctica. Section five is also put on hold and would address further development, future production requirements and hosting of the webtoon online once developed.

For the final section, the project concludes by emphasising how the comic as a science instructional tool has the potential to communicate science in Antarctica to the public in the more modern webtoon format.

1.1 Recognising the need for education, outreach & communication - the fourth IPY

The International Council for Science (ICSU) report by Provencher et al. (2011) describes how polar research education, outreach and communication (EOC) was underlined during the fourth International Polar Year (IPY) 2007 – 2008. The IPY set out to "engage members of the public in active polar science endeavours on a global scale". The ICSU report findings acknowledged that the public want to get involved in science and that scientists need recognition for EOC programmes that they are involved in.

The ICSU report suggests that the Instructional Intelligence models: ongoing assessment, reflection and adjustment traditionally used for education are reliable processes to follow to ensure continued effectiveness of EOC programmes, (Provencher et al., 2011). With the Association of Polar Early Career Scientists (APECS) "carrying forward the momentum of polar research, education and outreach", some of the main steps required to maintain EOC programmes require scientists, educators, communicators, public and media to learn from each other and integrate during professional development activities, (Provencher et al., 2011). Lessons learned from the IPY that are important to consider when designing science and outreach and communication programmes include that "the public, students, teachers, media, artists and musicians want to be actively engaged in science" and that "In many cases, science EOC has moved beyond the traditional poster or pamphlet, but more needs to be done to ensure that outreach efforts are reaching target audiences", Provencher et al. (2011). The need for public engagement with the science community and the driving wheels of new global communication tools calls for the integration of EOC and science, and has in turn made public science literacy a "critical component" of science discourse, (Provencher et al., 2011)

Schroeter, Lowther, Kelman, and Arnold (2015) discuss the challenges of communicating Antarctic Climate Science and introduce an "Antarctica Climate Education, Outreach and Communication

Standing Committee" as part of a mechanism for overcoming the challenges. The aim of the proposed committee would be to "provide the foundation for boundary work" between climate science, policy and EOC strategies in an attempt to tackle misinformation and how the general public interprets issues surrounding climate change and how Antarctica interacts with the "global climate system" (Schroeter et al., 2015). Television, newspapers and the internet are highlighted as the most popular modes of visual communication of climate science used by people in Australia and USA, half of which were wealthy, educated 22 to 35 year olds, (Schroeter et al., 2015). The need for alternative mediums for spreading an awareness of scientific information is recognised with a view to targeting "a variety of audiences" with the onus on scientists "to frame information in a way that is accessible to the public" without jeopardizing accuracy, (Schroeter et al., 2015).

1.2 Generation N Education & Communication

One possible alternative to traditional science communication mediums is the comic. The graphical form of the comic has predominantly provided the masses with entertainment and more recently with edutainment (Trnova, Trna, & Vacek, 2013). Using comics as educational tools for teaching science is becoming more popular and their gaining popularity in pedagogy (learning theory of children) and andragogy (learning theory of adults) is in recognition of the visual literacy of Generation N (Trnova et al., 2013).

To make a broad generalisation of people born into a digital age, and not all of whom are tech-savvy, Generation N "plays to learn", learning to use technology by playing with it (Feiertag & Berge, 2008). Also known as the Net Generation, Generation N are the group of people born after 1980, that are characterised as having grown up in the company of the internet and who can move between reality and the virtual environment with great ease (Trnova et al., 2013). Students of Generation N are reported to lack engagement with "course-text" (Gorlewski & Schmidt, 2011) and have difficulty reading and deciphering long manuals and texts, skipping topics that are not of interest just to finish the task (Trnova et al., 2013).

The theories of andragogy apply when teaching Generation N as the generation expect an "egalitarian environment" to work in and a say in their education (Feiertag & Berge, 2008). Generation N prefer some control over how to progress through any task, doing best in a structured yet guided process that includes feedback and immediacy to motivate their progress (Feiertag & Berge, 2008). A study by Özdemir (2017) observes that humour used in the classroom can increase the instructional immediacy of the teacher and therefore reduces the somewhat intimidating social

gap between the student and all-knowing educator. Özdemir (2017) also suggests that humorous comics, when used tactfully as a learning aid, may contribute to the learning atmosphere and to a more positive student attitude towards science.

Connected daily to their peers through many different online applications, Generation N are motivated by "real-life" experiences that they share in a context that they are familiar with (Trnova et al., 2013). Rote learning is not the preference of the generation, memorising and regurgitating facts that are otherwise easily found on the internet does not seem useful (Trnova et al., 2013). With a "hypertext mindset" learning in a non-liner fashion bouncing from task to task, Generation N prefer to share information, do best in group activities and prefer to learn from their peers (Feiertag & Berge, 2008).

Engaging more with visual stimuli and having greater proficiency with visual modes of peer-to-peer communication, Generation N obtain abstract concepts more readily. Cartoons and Comics suit Generation N as a visual mode of communication and where "little text suits them perfectly" relatable cartoons and the sequential structure of comics meet some of the preferred learning and communication criteria of the generation (Trnova et al., 2013). As a visual mode of communication, coupled with the fact that comics are already easily accessible through many mediums such as newspapers, magazines and Internet (Özdemir, 2017), comics could be more effectively used as an communication tool used to engage Generation N with science in Antarctica.

1.3 Classification of Narratives in the Graphical Form – the cartoon, comic and webtoon

A 'cartoons' and 'comics' are an everyday concept but for academic purposes require some unpacking. The terminology used to describe the many different types of narratives created using the graphical form is inconsistent in existing scholarship. For the sake of clarity and understanding the following classifications, outlined by Trnova et al. (2013), are adopted here.

According to Trnova et al. (2013) a 'cartoon' refers to a single frame image, depicting a two-dimensional work of art that is not usually realistic in style. Cartoons can have both an image and a text component or just an image and generally provide humour and entertainment to the public. A 'comic' refers to the form where two or more cartoons are combined sharing the same storyline. It is in two-dimensional format and is more likely to include a text component but not always. The images or cartoons in a comic are called panels and the panels can be arranged in many different configurations with a linear or horizontal "strip" arrangement being the most popular. Cartoons are

more traditionally known in newspaper and tv entertainment and comics in magazines. Currently cartoons and comics are gaining popularity online.

Figure 1: Single Panel Cartoon – 'The Polar Bears Finally Migrate to Antarctica' by Farley (2018)

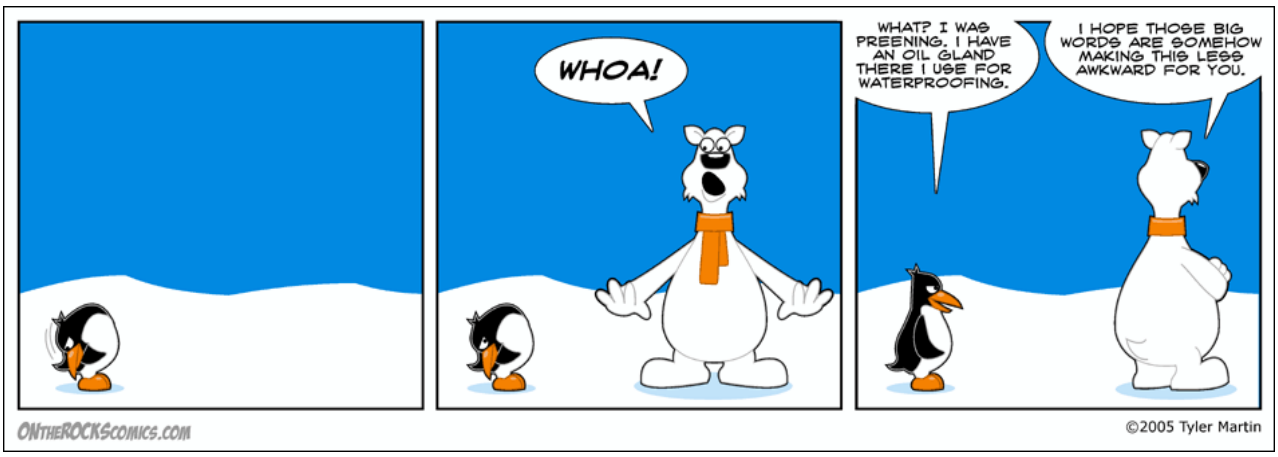

Figure 2: Horizontal Comic Strip 'Wally and Osborne' – 'Preening' by Martin (2005)

The terms 'webtoon', 'web-comic' and 'line-comic' are used interchangeably when referring to the online mediums of 'cartoon' and 'comic'. The term 'webtoon' can be used more specific to refer to the "long form" or vertical configuration of panels in comics, where the scrolling format on smartphones and computers is required to read it. However, the term is also popular and used when referring to online cartoons / comics in general regardless of panel configuration (Heekyoung, 2016).

2 Comic Narratives in Education

Earlier in the report Generation N are introduced as a generation of people that "plays to learn" (Feiertag & Berge, 2008). Generation N expect to have control over how they are educated and prefer to learn through sharing with their peers than from course-text in a rote learning environment (Trnova et al., 2013). It is this preference to play, learn and share that researchers have used to realise that Generation N learn best in their own leisure time.

Research by Hughes-Hassell and Rodge (2007) champions "leisure reading" as one of the more focused elements of well-regarded literacy initiatives and relates leisure reading to achievements in content knowledge, vocabulary, comprehension and verbal fluency. Students who choose to read their preferred medium in their own time and not just books achieve acceptable levels of reading where previously they might have "hit a literacy ceiling", (Hughes-Hassell & Rodge, 2007). In the study by Hughes-Hassell and Rodge (2007) students were found to have three main reasons for undertaking leisure reading: fun and relaxation, to learn new things, and because they were bored. The same study indicated that the most favourite mediums used in leisure reading were, in order of preference: magazines, comics and internet. It is not wrong to point-out that these three mediums have visuals and images as a common thread.

The findings of a study by Liu (2004) report that the comprehension of a text and how well a text is remembered are successfully facilitated by the use of narratives with images, particularly comics as an educational tool. Liu states that when teaching English language, comics are particularly successful with students who start out with low level comprehension of text as opposed to students with already high text comprehension scores. Similarly, Hosler and Boomer (2011) state that traditional textbooks used in education for conveying science information to students are not always successful at communicating in an engaging way, especially to students who are new to the language of science and have no previous science education.

2.1 The Success of Comic Books in Science Education

Comic narratives successfully facilitate text comprehension in education but how effective are comics in facilitating science education particularly? In the article 'Are Comic Books an Effective Way to Engage Nonmajors in Learning and Appreciating Science' by Hosler and Boomer (2011) a science comic book 'Optical Illusions' is comparatively assessed with a view to determining whether comics are an effective pedagogical tool for conveying scientific content and improving the overall attitude

of undergraduate students towards science. Hosler and Boomer (2011) explain that the aims of the assessment coincide with the American National Science Board (NSB) initiative for Communicating Science and Technology to the Public, where the goal of the initiative is to find a way to communicate how fascinating, fun and useful science is.

In some cultures, the comic book narrative has a negative stigma attached to it (Hosler & Boomer, 2011) but the comparative assessment results of 'Optical Allusions' indicate that the comic book is as effective as the traditional textbook when preparing students for content knowledge tests. Moreover, with data generated by the NSB, the article by Hosler and Boomer (2011) determines that traditional science textbooks now contain more content with less coherency. Complementing the data from the NSB, the results of the comparative assessment in the article suggests the possibility that the sequential layout of the comic strip allows for a more coherent display of science information that is easier for students to follow than the less coherent textbook. In addition to coherency of information, Hosler and Boomer (2011) mentions that the cliff-hangers used to connect each comic story generate enthusiasm in the reader to learn more.

Overall, the article indicates that science information delivered through a comic book improves the attitudes of entry level students towards science and engages students more with the content (in the case of, the assessed comic book 'Optical Illusions', biology). Hosler and Boomer (2011) add that the comic book is at least just as good as the traditional textbook for science content delivery when it comes to content recall: the perceived compression of language of the comic book did not have a negative impact on student knowledge content scores. The success of comic books for content knowledge transfer is important to note where scientists fear misrepresentation by the media through oversimplification of science information and increased risk to the credibility of scientific data (Schroeter et al., 2015).

2.2 Interpreting Cartoons and Comics for Science Education

There are many different types of comics (and cartoons) used in science education, varying in graphic style (both image and text), panel configuration and science information content (Trnova et al., 2013). Trnova et al. (2013) set out a brief explanation of four different types of comics (including cartoons) that are used in science education, with an insight into how each are interpreted. First, in the single image stand-alone cartoon that makes use of "satire, irony and humour", the main method of communicating science information is by using one image that may have some accompanying text. Moving on from the stand-alone cartoon is the "scientoon" which is still a single image, containing

text related to the image but with an additional panel of "continuous text on the side" providing brief explanations to the science topics involved. The next type, the concept cartoon, is again a single image but with "a group of characters discussing a certain issue" using "speech balloons", with each character suggesting a solution to the scientific problem at hand. Finally, comic strips – that is a short series of humorous cartoons joined together - are also used in science education, motivating students to move on to each panel to learn more about the science subject.

Figure 3: Single image / panel Cartoon – 'Penguin Therapy' by Davidson (2010)

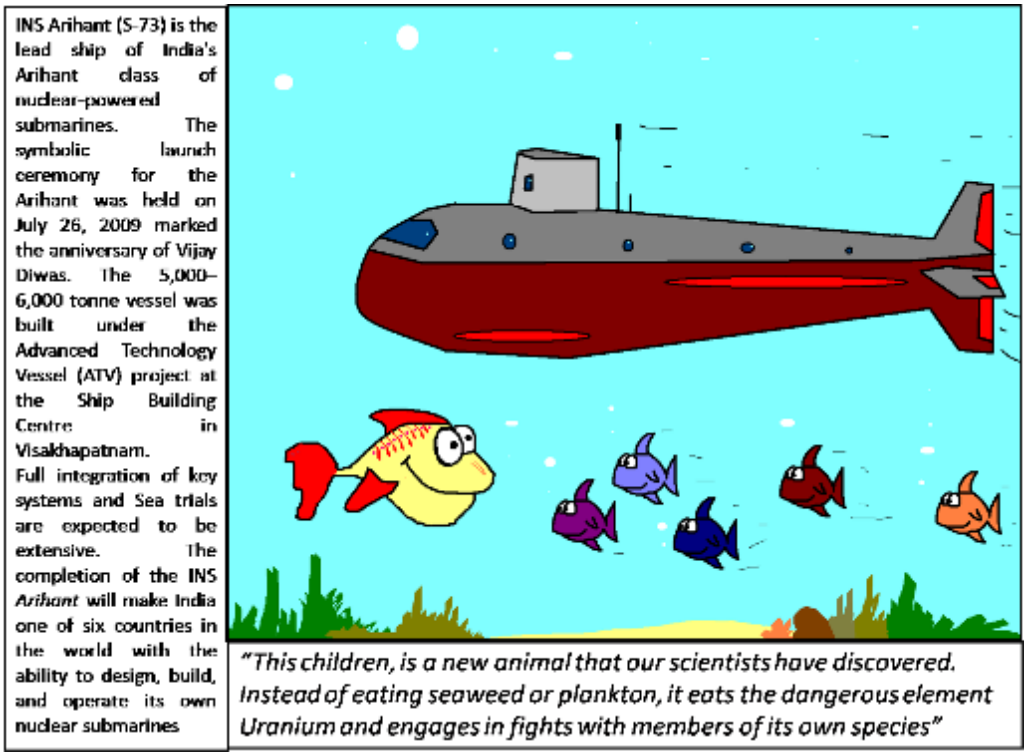

Figure 4: Scientoon – 'Submarine' by Puneet (2010)

The common thread between the four types of cartoons/comics outlined is that they all use images / pictures to help students understand and remember the science information. Combining with short text, the ability to drive emotions, and the sequential storyline of a comic, makes the learning journey all the more enticing (Trnova et al., 2013).

Trnova et al. (2013) set out five main "principles of creation of educational science cartoons / comics" including; minimum use of text making for ease of access to students of all ages and literacy levels, scientific subjects linked with familiar everyday events, alternative views presented to help identify possible misunderstanding, only scientifically accepted views are included, and alternative views are represented equally to avoid biased influence. Where comics are used to represent science information, research by Silva, Santos, and Bispo (2017) states that it is also important that the information communicated is as accurate as the facts generated by scientific researchers.

Table 2.1 Benefits and Risks of using ESCC (Educational Science Cartoons / Comics) reproduced from Trnova et al. (2013)

Benefits	Risks
Great motivating potential	Excessive usage, inappropriate choice of content and inappropriate usage in lessons reduces motivational effects
Short concise texts suitable for the current Net generation that refuses to read long texts	Shortening and simplifying of texts may result in ambiguous and scientifically inaccurate statements. If students do not create ESCC themselves and are not forced to seek and process information, skills for working with text and reading literacy are not developed.
Putting subject matters into meaningful contexts	Fixation of a phenomenon and its solution in a given situation associated with the phenomenon in ESCC. Students can mismatch a particular situation shown in ESCC with the observed phenomenon or concept and they will not be able to match it with other conditions. Therefore, ESCC should include various alternative presentations of issues to avoid misconceptions.
Visualization of issues - images representing issues to be solved	
Identifying and removing misconceptions	
Interdisciplinary approach - using science knowledge and skills, mother language, art, ITC and very often English	Students can consider requirement for interdisciplinary skills an obstacle. However, it can be solved by appropriate guidance and help of the teacher and the choice of an adequate level of ESCC assignment.
A significant part of informal education, whether in the form of printed materials, or interactive materials on the website	Wrong processing of ESCC (text simplification leading to confusion and errors) without feedback of acquired outcome can lead to fixation of incorrect explanations and misconceptions. Prevention is respecting principles of ESCC creation and presenting alternative views on issues, which can help to identify possible misunderstanding and teach students to distinguish between the alternatives. It is necessary to combine ESCC with other teaching methods and tools.
Support of constructivist teaching approach - students acquire knowledge of natural phenomena based on gradual inquiry enabled by depicted situations, they do not accept only complete knowledge	

Cartoons and comics are not the only solution to science in education but are simply a medium used to generate interest among students towards scientific subjects (Trnova et al., 2013). How cartoons and comics are used as tools of science education can also affect the outcome. When used as an "active teaching strategy" where students are involved in making the comic, comics can assist in reducing the gap between "theory and practice" of the subject matter (Silva et al., 2017). As with all the benefits of using cartoons and comics in science education there are also risks, as outlined in table 2.1.

2.3 Comics in Science Education and Science Communication

There are cross overs between science education and science communication in that the pedagogy used to teach students involves groups of communication tools proven effective for teaching certain subjects. With science education having more research behind it historically, it is possible to use this knowledge to determine the effectiveness of different mediums such as narratives and storytelling to communicate science with audiences outside of (if not also part of) the realms of education, reaching a wider public. It is this message that Negrete and Lartigue (2004) discuss in the article 'Learning from education to communicate science as a good story'. Science education and science communication are different by means of audience, chosen themes, methods of delivery, reason behind delivering information for each discipline and the institutions involved but the main similarity is that both aim to convey science (Negrete & Lartigue, 2004).

For the sake of clarity, science education could be defined as involving; an audience of students in third level education, who are studying science in Antarctica, who are guided by lecturers and scientific research for the delivery of information, with education and scientific credentials as a drive to stay informed and up-to-date as their main reason to engage with the information, and who are / were members of a formal educational institution.

As opposed to science communication that could be defined as involving; the general public profiled as Generation N, with Antarctica and what happens there as their interest, who use popular online social media platforms to deliver and share information, with entertainment and a drive to stay informed and up-to-date with their peers as their main reason to engage with the information, and who are outside of a formal educational institution.

Interestingly, Negrete and Lartigue (2004) liken the structure of scientific explanations to that of a narrative, "with protagonists (studying electrons and genes) that enact a sequence of events with an

outcome (the phenomenon to be explained)". The structure of narratives describing events in order of occurrence and "casual conversation of a character in a novel" make the language of the science easier to understand and remember when compared to the more factual authoritarian approach of more traditional science textbooks. Mass media narratives have an important part to play in effective science communication and learning, with Negrete and Lartigue (2004) listing radio, television, news, magazines, music, cinema and fictional narratives including the science fiction novel - *'War of the Worlds'* by H.G. Wells, (first published in 1898) that has since translated into many forms including illustrations for a musical and comic books.

As in the previous section of this report where comic narratives are seen to entertain and engage the student, Negrete and Lartigue (2004) champion the same "fun" attribute unique to narratives and storytelling because "fun" makes for pleasing, entertaining and stimulating learning albeit necessary "hard fun" in science communication narratives. The authors of the article discuss how "the freedom of interpretation", imagination and engagement can "foster a pupil's interest in science" and highlight that stories read in childhood are an influencing factor in the career chosen by scientists.

The effect that emotions in general have on creating long-lasting memories is also acknowledged in the article by Negrete and Lartigue (2004), with a positive correlation generated between enhanced information recall and learning through reading narratives. The reason for this is that narratives leave room for excitement, imagination and the reader's own interpretation. When reading traditional science textbooks that are respected as more of "an authority" with more facts and no ambiguity the reader has less to do and less to add to "the story" and is therefore less engaged, feeling disconnected or scared of the language, reducing the "take home pay" of scientific information. On saying that, science narratives and traditional science textbooks both have their own jobs to do in science communication with narratives having the job of exploring ideas and textbooks providing a reliable link to the required structure (Negrete & Lartigue, 2004).

Özdemir (2017) highlights that there are not many comic narratives in mass media that are "explicitly scientific" and yet promotes the communicative value of humorous comic narratives as feasible instructional tools worth developing to aid enjoyment of science in the classroom. The article 'Comics as a Tool for Inquiry' by Sousanis (2012), is written in comic book format and is a marvellous example of the communicative potential of the comic narrative. With the dissertation and thoughts of Sousanis presented graphically with text, the paper challenges the traditional conditioning of academia and the preference for course text and flat imaging of data (like charts, graphs and images

without depth or rendering). Sousanis (2012) demonstrates that the "arts, comics and visual thinking" are not just aesthetics "…but essential as a means of enabling multi-dimensional sight" to our way of thinking and presenting our thoughts. The paper 'Sequential Art for Science and CHI' by Rowland et al. (2010), where CHI is the acronym for Human Computer Interaction, is also written in comic book format to "further explore and highlight the communicative capabilities of the medium, one that can be visually attractive and facilitate rapid dissemination to a wide audience". Rowland et al. (2010) champion the comic narrative as a means not only for entertainment and learning but also as a medium suited to serious scientific discourse.

3 The Webtoon – a Modern Version of the Comic

The 'webtoon' is the modern-day version and contemporary cousin of 'the comic'. As discussed earlier, comic narratives are used in the classroom for reasons of engagement, motivation, increased comprehension and information recall. The academic studies around webtoons (and/or web comics) however sparse, suggest that webtoons are also successful in education as instructional aids and tools, with webtoons made use of in reading comprehension (Ahamed & Harun, 2016) and for educating and generating debate on public social issues (Choi, 2016).

Leading on from previous sections of this project, the success of comics in science communication is for the same reasons that comics are successful in science education, as the comic narrative suits the learning and engagement preferences of the intended audience (Negrete & Lartigue, 2004).

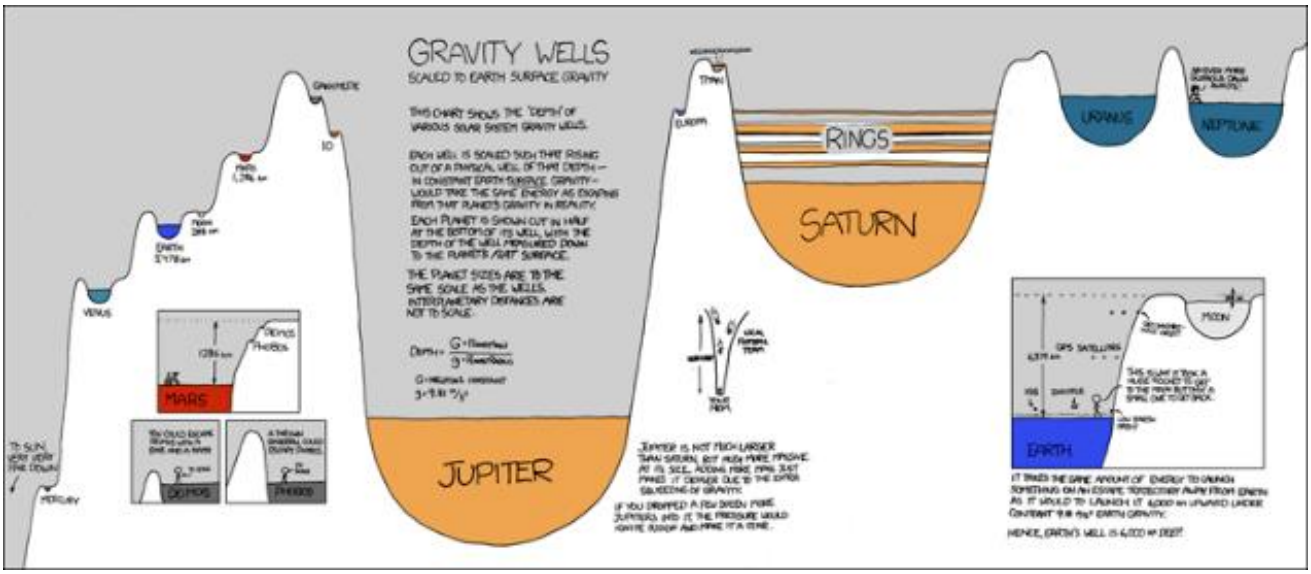

Figure 4: Web-comic 'xkcd', series 'Gravity Wells' (Munroe, 2017)

Although similar in reason for success, the webtoon has moved far beyond transferring a comic to a website online, (see web-comics; 'xkcd' by Munroe (2017), 'Foxtrot' by Amend (2018) and 'Boxplot' by Naro (2016)) and has developed into an even more powerful medium that engages the public readily and consistently using online applications that host webtoons specifically. The online hosting applications for webtoons have the power to link webtoons to range of other online entities such as websites, blogs and social media platforms. The format of the webtoon continues to evolve away from previous formats of the comic, and instead of the typical configuration of panels, webtoon illustrations have the potential to occupy infinite screen space, making room for more accurate interpretation of the subject and storyline. Users of webtoon applications not only read and learn from the webtoons they 'follow' and 'subscribe' to but also leave a 'comment' on webtoon series, engaging with other users, discussing subject matters of webtoons as they play.

3.1 Interpreting a Webtoon

Webtoons vary in layout and panel configuration, sometimes panels are not used at all. When accessing webtoons via a computer or smartphone, webtoons are viewed through a display that is orientated vertically instead of horizontally. This allows the reader to navigate the webtoon by scrolling up and down the page infinitely (Walters, 2009). Some webtoons are swiped left or right to replicate turning the page, but this is no as common as scrolling vertically. However, webtoons are still sequential in their layout and the reader is required to have visual and interpretative skills to understand the message communicated (Heekyoung, 2016). Webtoons move from scene to scene and often introduce cliff-hangers to entice the reader to watch out for the next episode / series, encouraging the reader to read further and to learn more.

The otherwise empty gutter space between panels in traditional comics, is made more creative use of in webtoons and is used regularly used to convey a clearer message to the reader. The gutters in webtoons can alternate in length, sometimes conveying a sense of time between each scene and/or are filled with colour to signify changing mood, weather or sense of space and depth throughout the storyline (Heekyoung, 2016).

3.2 Webtoons and Science Communication

In the same way that academic literature surrounding comics in science education provide an understanding for how comics are best used for science communication, the same can be said for webtoons in science education and webtoons in science communication. A study by Choi (2016) links both education and communication with successful public engagement using a webtoon. Choi (2016)

concluded that the webtoon under analysis 'Awl', "played a major role in introducing atypical topics in an accessible format to diverse people". It is this precise engagement with the public that was underlined by the fourth IPY with regard to education, outreach and communication of polar science albeit on a "global scale" (Provencher et al., 2011). The comment sections built into the webtoon platforms allow for critical responses from the public and corporate responses thus making room for discussion and alternative views on the webtoon topic (Choi, 2016) while at the same time reducing the gap between people outside the immediate realms of academia and the people of authority / knowledge content experts. Bringing the public and content experts closer together in discussion of a webtoon topic could help to reduce the fear of misrepresentation that could cause scientists to avoid media engagement (Schroeter et al., 2015).

The audience of a webtoon are engaged not only by aesthetic and the storyline but also by the emotional response to webtoon characters that "go through diverse emotional experiences following the sequence of each event" (Choi, 2016). Webtoons have the power to engage the public by generating emotional responses "making them confront the realities of society…", enabling the public to distinguish what is true by sharing their thoughts in a group environment and applying critical thinking to the storyline/data presented (Choi, 2016). It is the same effort applied to "making the invisible reality visible" using a webtoon (Choi, 2016), that could assist in how the public "interprets and understands the complex issues surrounding climate change generally and the impacts of climate change on Antartica more specifically" (Schroeter et al., 2015). The elements of public communication and engagement with a webtoon highlighted by Choi (2016) are typical of how best to educate and communicate with Generation N, where the preference of immediacy, emotional engagement and peer-to-peer sharing is echoed in academia previously cited in this project, ((Feiertag & Berge, 2008), (Negrete & Lartigue, 2004), (Özdemir, 2017) and (Trnova et al., 2013)).

4 Developing a Webtoon for Communicating Science in Antarctica

Artistic work and the use of aesthetic is a major characteristic of Webtoons, with each Webtoon having its own signature style that audiences use to identify the Webtoon creator. To develop a successful webtoon for mass communication of science in Antarctica on online webtoon platforms, formatting and creation of an actual Webtoon takes understanding of: the 'canvas' size required, choice of storyline layout, colour theory, interpretation of different sketching styles and knowledge of how to manipulate the software, (Corel Draw, Adobe Illustrator or Photoshop for example), required to transfer the manually drawn sketch to a digital format for online production.

An understanding of how the chosen target audience, in this case Generation N, prefers to learn and communicate is knowledge vital to maintain a successful science in Antarctica webtoon that continuously engages readers on a regular basis. As we can see from previous sections of this report, Generation N learn through entertainment, sharing information with their peers and having a choice in what information they learn. Webtoon platforms encourage all of things, with tools available for readers to entertain each other by 'following' specific Webtoons, sharing information from peer-to-peer, commenting on and discussing content and ultimately allowing readers to choose which Webtoon series and story they want to 'follow' and read.

The chosen Webtoon backstory and character development required for creating a science in Antarctica Webtoon would need to evolve around 'real-science' that accurately communicates science, avoiding misinterpretation of scientific facts. Current, factual storylines that are linked to popular mass media stories today, coupled with the expected satire of most Webtoons could help to draw the initial readers to a new webtoon, developing an audience that would later share new and interesting facts about the science that is happening in Antarctica.

The characters used in the Webtoon would need to reflect the current styles and habits of the target audience (Generation N) so that readers bond with the storylines and develop a relationship with and interest in the characters, following them on their journey. The cute factor and what people seem to associate most with Antarctica, penguins, could influence the nature of one or more of the characters in the Webtoon.

More thorough research and storyline creation for the development of a specific webtoon for communicating science in Antarctica was intended for this section and will be revisited later.

5 Producing a Webtoon to Communicate Antarctic Science to an Online Audience

Science in Antarctica outreach and communication with the public, as highlighted by the fourth International Polar Year (IPY), is the main objective for producing a Webtoon based on science in Antarctica. The aim of the Webtoon is not to generate revenue but as an open source or communication tool that would engage the public with science in Antarctica. The reason why Webtoons are considered here for communicating Science in Antarctica is because of the ability of online webtoon hosting platforms and 'apps' to reach the public on a global scale. It is possible to create links between webtoons and websites, where webtoons are used as content for websites of businesses involved in the same area of Science, Technology, Engineering or Maths (STEM).

Considering this, AntarcticaNZ was contacted for this project and their communications department supported the idea of a science in Antarctica webtoon linked to their website and media sections.

More in depth research of online webtoon hosts and applications, (with 'Webtoon' currently the most popular), was intended for the sake of understanding the expectations of each platform audience, platform hosts, rules and regulations, financial costs and legal issues revolving around copyright and branding. Again, due to time constraints, it is intended to revisit this section of the report and webtoon production issues later.

6 Conclusion – Webtoons used to Communicate Science in Antarctica

The comic as a science instructional tool has the potential to communicate science in Antarctica to the public in a more current and modern format by using the Webtoon. Webtoons are engaging and motivate the readership of Generation N to read and learn more.

Webtoons already produced and circulating on mass media platforms are breaking down barriers, using humour and satire to convey messages, allowing the public to engage in current global debates and areas of expertise previously outside of the everyday conversation of 'regular' people.

The design and creation of a successful science instructional tool such as a comic, requires planning, research and an understanding of the learning requirements of the target audience. The project highlights that an understanding of the pedagogy / andragogy required to educate Generation N, when applied to the design of a webtoon would ensure successful communication of science in Antarctica to the public. Accurate science content, obtained from reputable scientists and academic publications, is required to design a credible webtoon that accurately reflects science in Antarctica and one that avoids misinforming the public. Coupled with the expectations of webtoon followers who expect to receive new weekly episodes of the webtoon, using a webtoon to communicate Science in Antarctica requires a level of commitment no less than any other online mass media platform that aims to maintain readership.

7 Recommendations and Further Research

To create a successful webtoon for communicating Science in Antarctica, I recommend further research into the development of a webtoon and what it takes to develop a webtoon as far as 'ready for production'. In-dept knowledge is needed of the webtoon 'canvas' size required depending on the chosen online platform, possible webtoon layouts, colours used in the webtoon and associated

colour theory and interpretation of different sketching styles used for drawing the webtoon. Knowledge and skills using illustration software, such as Corel Draw, Adobe Illustrator and Photoshop, are also required for manipulating the sketches created manually into online digital formats.

Understanding the expectations and learning requirements of Generation N is required for the success and mass sharing of a science in Antartica webtoon. I recommend that any webtoon developed is tested by people of Generation N for 'interesting' and 'entertaining' values to ensure mass use of the webtoon by the intended audience. I also advise further research into character development and how Generation N 'see' themselves. Developing characters that 'look like' they belong in Generation N will allow people of the generation to associate their own lives with the characters in the webtoon, while at the same time envisage themselves in the storyline, getting involved in science in Antarctica.

The production of a useful webtoon based on science in Antartica requires research into the different online platforms and applications that host webtoons. Each platform has different rules and expectations of its readership and hosts. Legal issues surrounding copyright and branding also need consideration whether the webtoon is considered only as an open source of information or not. This is to ensure the intended use of the webtoon and quality and accuracy of scientific storylines.

Finally, I recommend developing factual storylines for the webtoon based on real science in Antarctica. It is important that the webtoon communicates accurate and credible information so as not to misinform the webtoon readership. The development of storylines on science in Antarctica would require further research into information sourced from credible scientists.

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